AIRS Calibration Status

October 5th, 2018

NASA Sounder Science Team Meeting

Steve Broberg

George Aumann, Evan Manning, Thomas Pagano, Chris Wilson, William Mathews
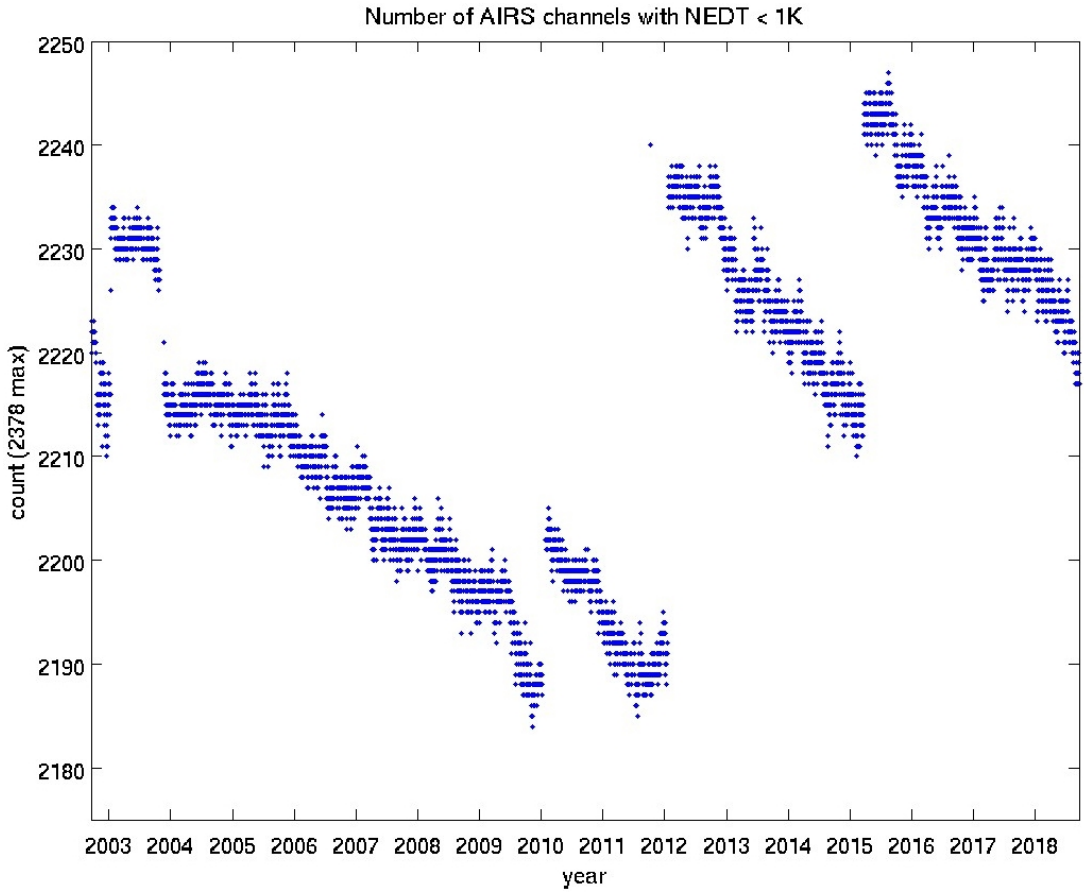Jet Propulsion Laboratory, California Institute of Technology

- Operational (at instrument) - A/B detector changes
  - 2104 of 2378 channels have redundant A & B detectors
  - there have been occasional table uploads to restore/improve/optimize degraded channels
  - last was in 2015, next will be fall of 2018
- Calibration characterization
  - AIRS calibration continuously evaluated (currently at-launch calibration in use, aka "V5")
  - Some time dependent trends exist
- New proposed time dependent calibration coefficient set
  - Uses mission long analysis of AIRS space view response   (Pagano talk to follow)
  - Physics based improvement of the coefficients (i.e., not based on comparisons to other instruments or earth scene/model references)
  - Time dependent polarization factor, phase terms
  - Smoothed blackbody emissivity; Separate A and B side Nonlinearity
- Coefficient conversion software developed for various data sets
- Develop plans and procedures for safe instrument operation in the changed thermal environment during and after Aqua A-Train constellation exit maneuver in March 2022.
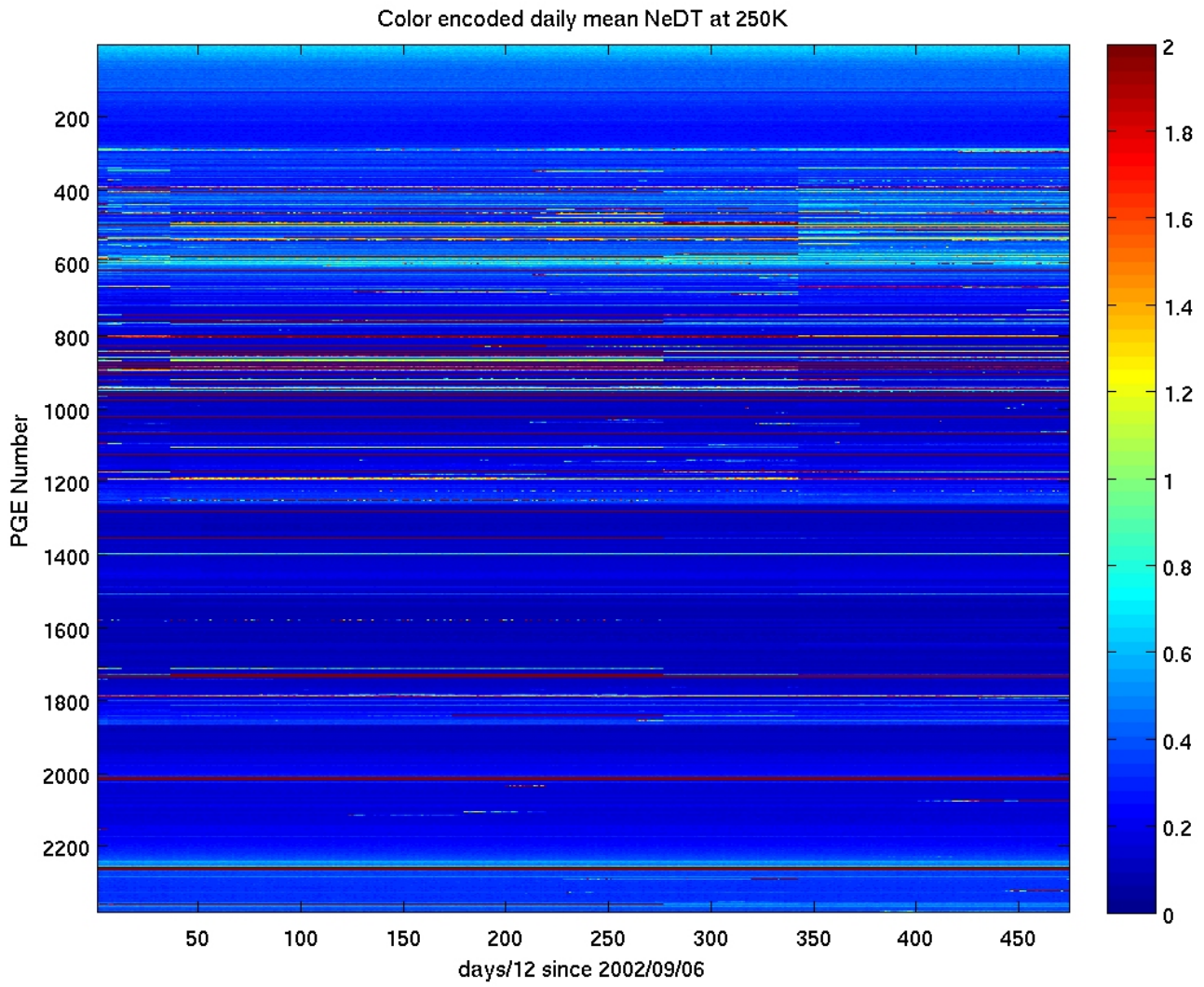
Number of AIRS channels with NEΔT < 1K

"image" view of health, channel vs. time

GainTable loads

2003-01-10   2013-06-10
2003-11-18   2015-03-23
2012-01-21   2018-xx-xx

Instrument Events

2003-10-29 Solar Flare safety shutdown
2010-01-09 28V SEU
2014-03-22 Cooler A   58K-> 68K
2016-09-25 Cooler A   58K-> 68K

- Previous slide shows about 30 channels have increased above a 1K noise threshold since last update – some of these will have good redundant detectors and can be recovered

- We automatically track channels whose NEdT has changed, for the better or worse, by 50% or more – so a channel which has changed from 0.2 K to 0.4 K is noted and also a candidate for recovery. Some do improve as well.

- We are currently tracking ~50 channels which have had increased noise noted since the last table upload.

- Channel 2333 (2616 cm-1) degraded in early 2017 and further in early2018 is a key driver for the upcoming change – it is one of the channels selected for the current Calibration Data Subset.

AIRS L1B QA NEdT Data for Channel 2333

M-01a Chan 2333 (2616.383 cm^{-1}) C2 Guard Test A-B NEdT

R: A side
B: B side

Switch to B only will recover channel
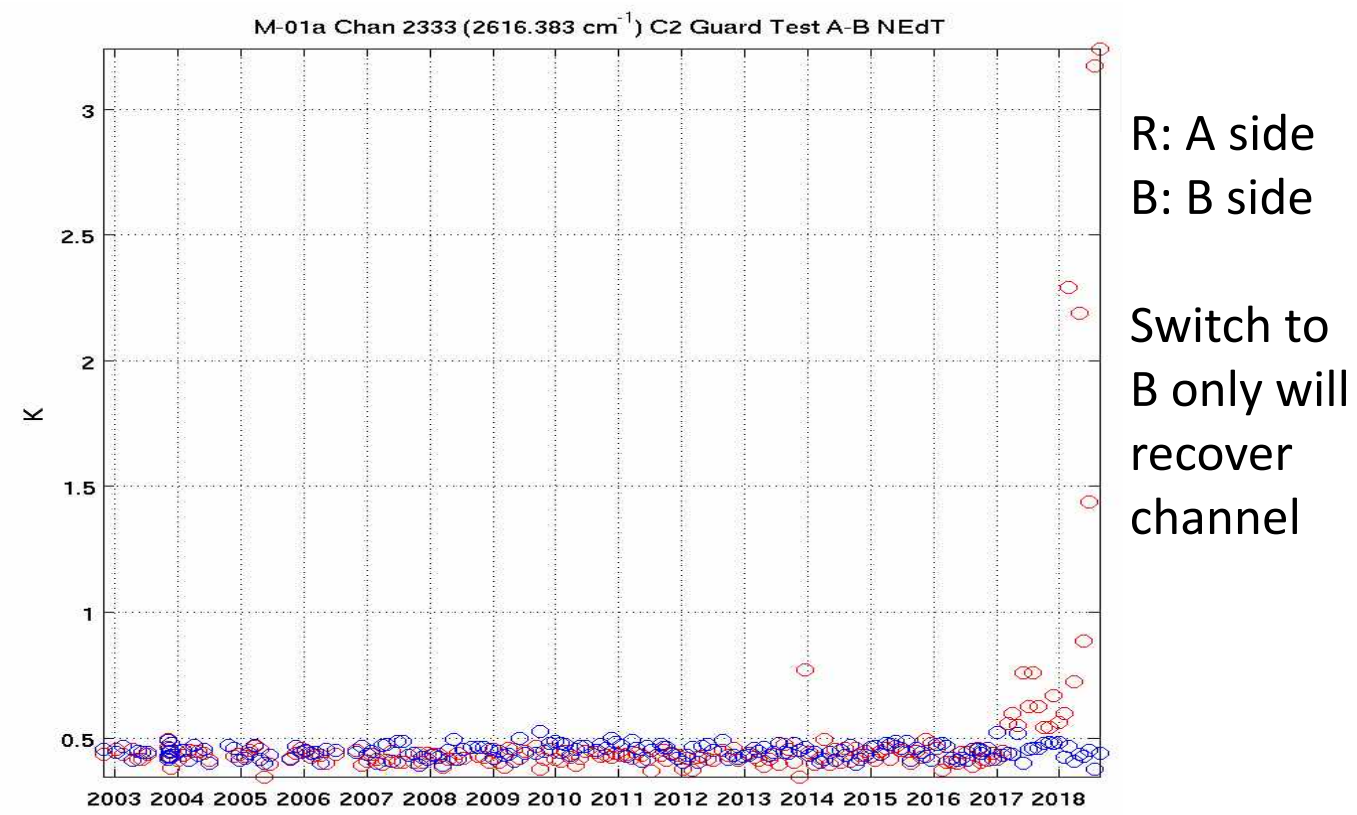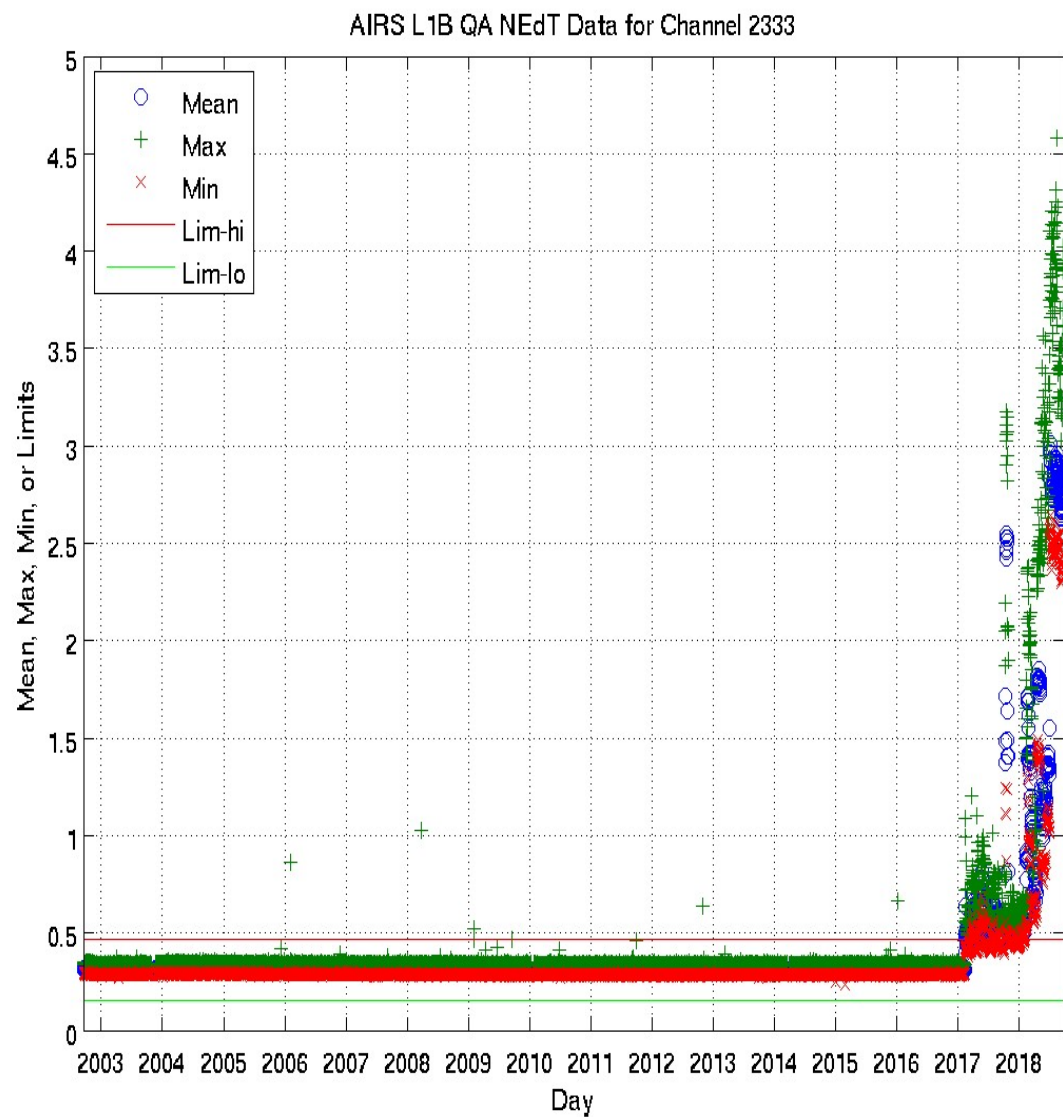
Original change was not large, 0.3K to ~0.5K

Thought to be insignificant for analyses using large averages.

However, performance degradation at this scale does have an impact for some analyses, and channel has subsequently degraded further, necessitating a recovery.

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- **AIRS Calibration Team Continues to Trend Performance and Improve AIRS Accuracy**

  - "Trends in 16 years of AIRS hyperspectral infrared data", SPIE 10764-24 (Aumann)

  - "Stratified radiometric means for the evaluation of AIRS and CrIS", SPIE 10764-25 (Manning)

  - "Reducing uncertainty in the AIRS radiometric calibration", SPIE 10764-23 (Pagano)

  - "Updates to the Absolute Radiometric Accuracy of the AIRS on Aqua", Proc. SPIE 10781-26 (Pagano, September SPIE Asia-Pacific)
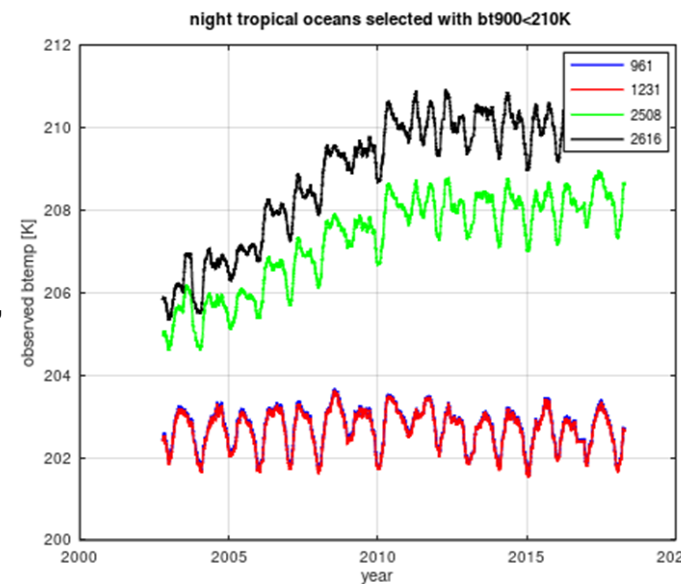
Trends in window channels at T < 210K; Scatter?
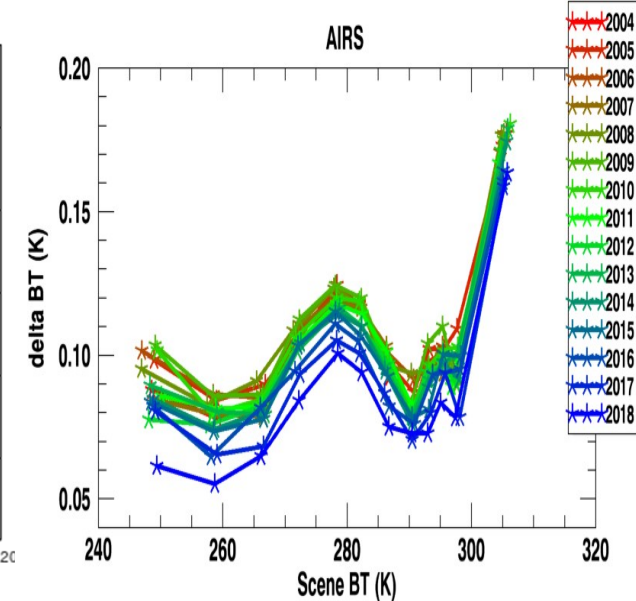
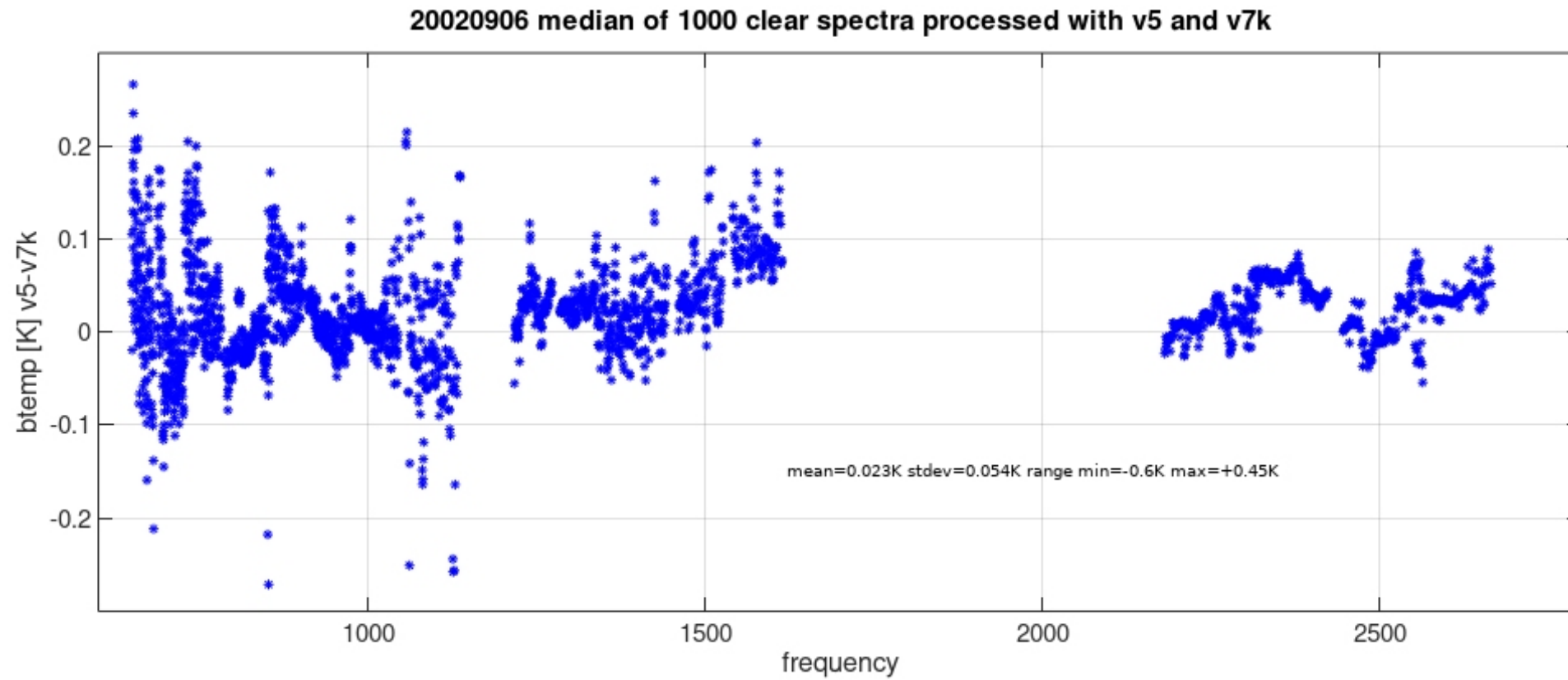Stratrad scene dBT over 15 years
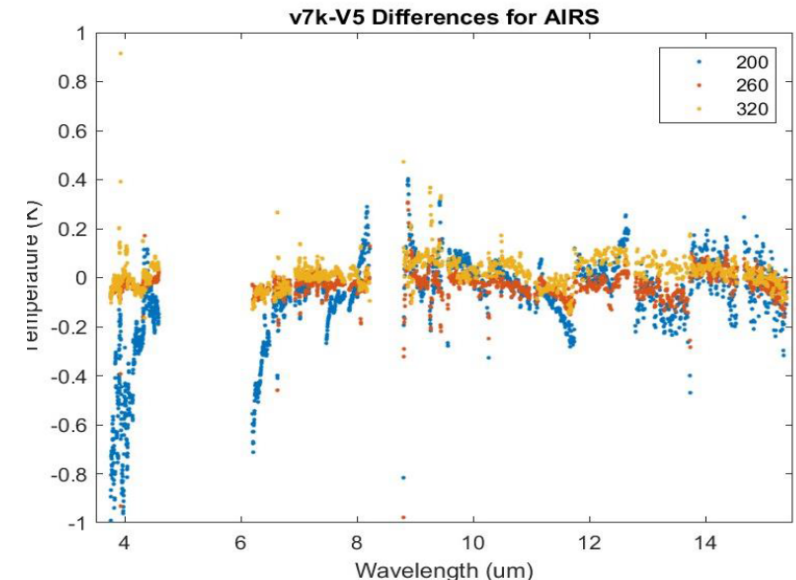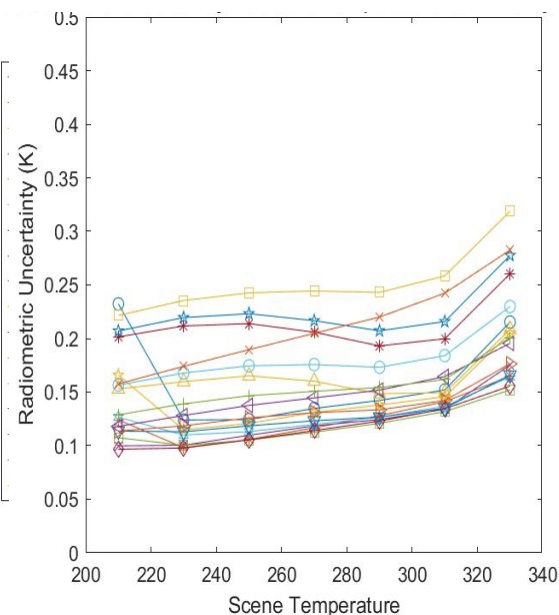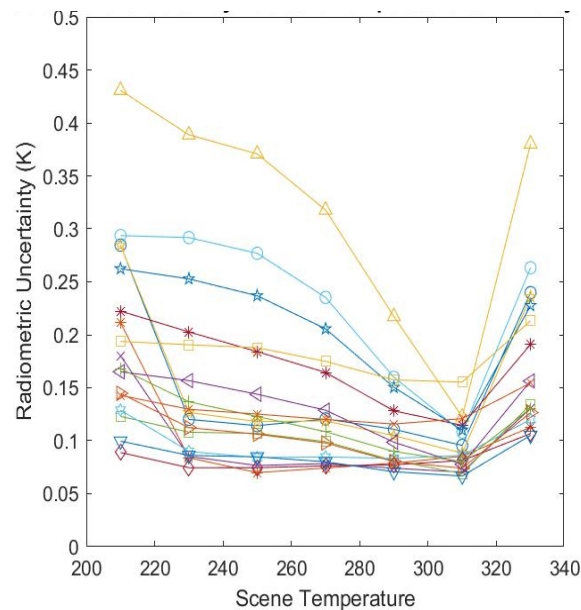
v7k-v5 largest at cold temps
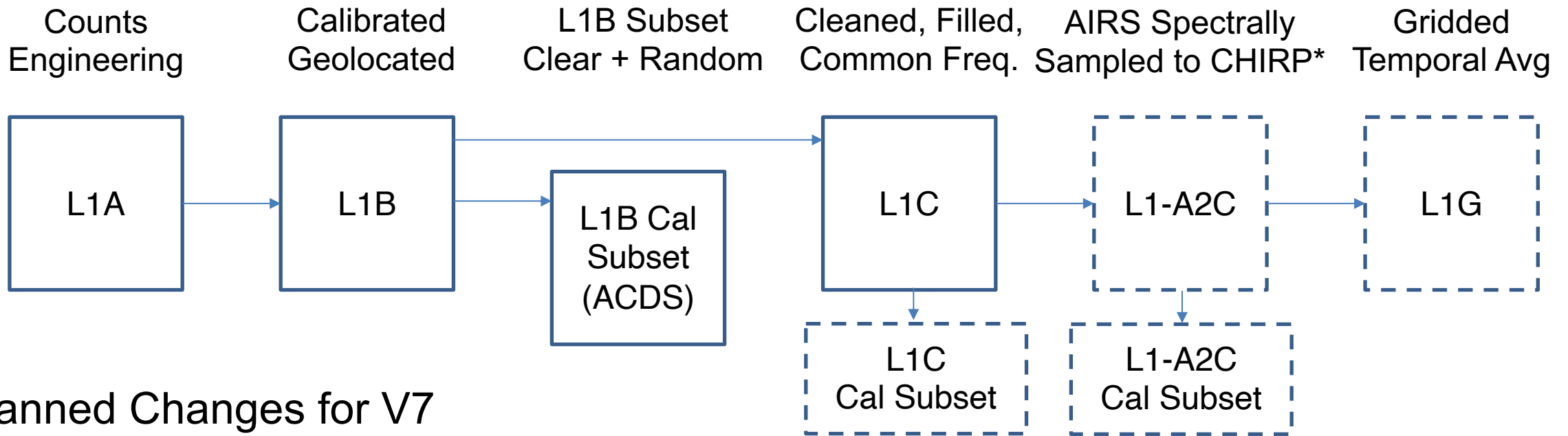
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- Cal coefficient converter developed to quickly convert existing v5 data sets to v7k
- Recently we created data sets with 21,000 Random Nadir spectra each day from every 12th day between 20020906 and now (474 days) using the v5 calibration. We can now compare spectra from the same scene using the v5 and v7k calibrations using the quick converter.
- The plot below shows the pairwise difference between spectra. (1000 clear spectra)
- The differences are typically less than 50 mK.

20020906 median of 1000 clear spectra processed with v5 and v7k

mean=0.023K stdev=0.054K range min=-0.6K max=+0.45K
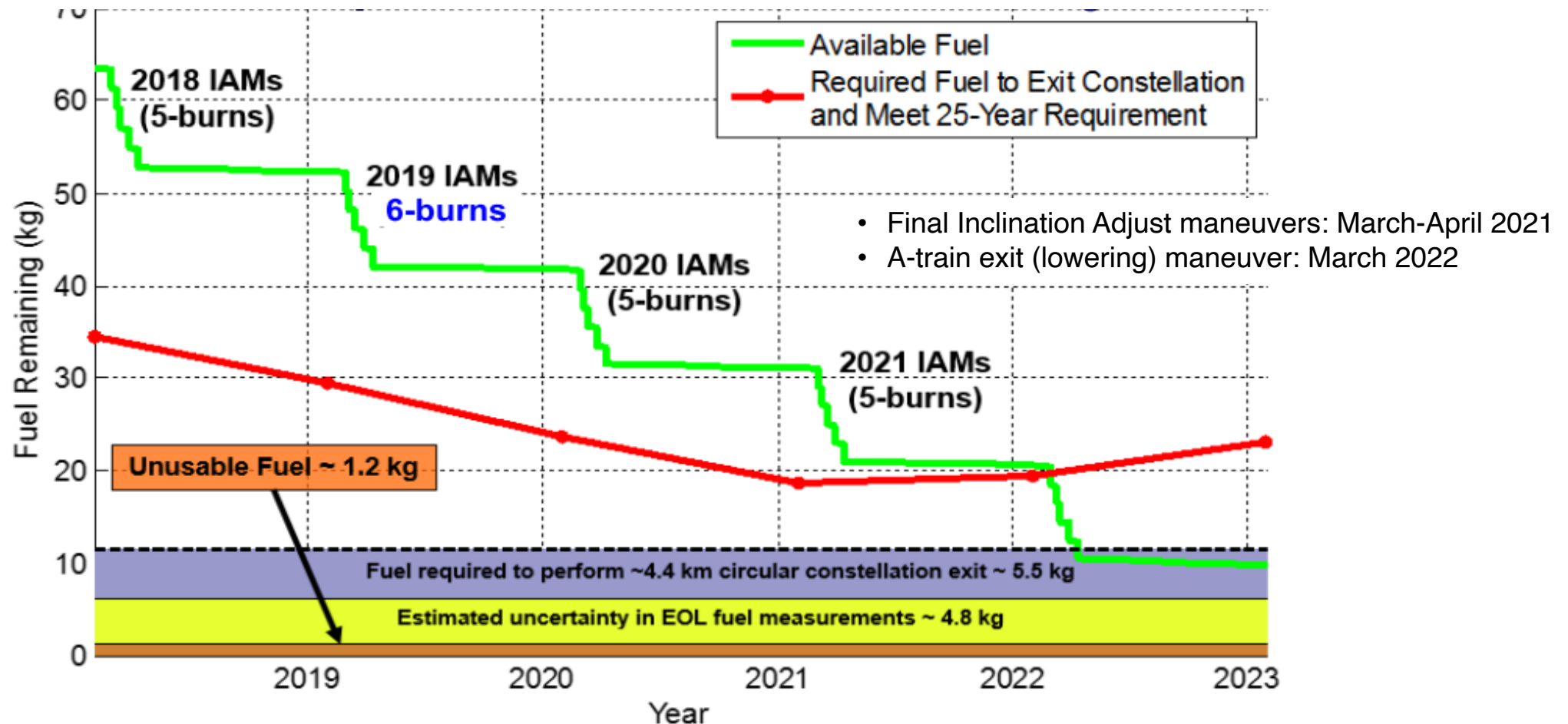
New Level 1 Products Planned for V7

- Changes ready to go

  - Increase precision of radiances

  - Spectral estimate per granule (Bob Deen version)

- Changes to be implemented (TBD, partial list)

  - Spectral estimate per scan (newer Strow model – new version may need refinements)

  - Non-gaussian noise characterization

  - Pop/moon detection dynamic thresholds (monthly files vs. 6 minute granules?)

  - Clear, SO_2, and dust flags (new algorithms, include in L1B?)

  - Scene homogeneity ("C_{ij}") - improve metrics

  - Update to calibration coefficients (A/B independent, time dependent polarization)

- Some consideration being given to reprocessing on a monthly basis vs. 6 min granules

- Initial version is available—does cleaning and gap filling well

  - At the GES DISC they maintain a rolling 1-month of products

- V6.9: Proposing releasing an updated fixed frequency grid for the whole mission near term
- V7: Would have an improved replacement algorithm
- Improvements being considered

  - spectral model from Strow

  - spectral resampling (to fixed grid)

  - improve buddy first-pass replacement

  - improve outlier detection

  - estimate of fill value "goodness"

  - better PCA training set from UMBC

  - better scene inhomogeneity (C_{ij}) metrics/handling (PC 100 current, PC 20, MODIS, other?)

- AIRS is expected to last the life of the spacecraft
- Post-2022 orbit will also have thermal impact on AIRS – specifically, 2nd stage heater will need to draw more power to maintain spectrometer temperature
- Thermal/calibration impact being assessed with spacecraft and instrument models

- Final Inclination Adjust maneuvers: March-April 2021
- A-train exit (lowering) maneuver: March 2022

- AIRS is has been operational since 2002
- AIRS is healthy, with as many < 1K channels as at launch.
- AIRS is currently using the at-launch calibration coefficients
- New calibration coefficients have been developed and are currently being evaluated
  - Uses a physics based improvement of the coefficients (i.e., not based on comparisons to other instruments or earth scene/model references).
  - The new coeffients also has potential to account for some of the time dependent artifacts.
- L1C is available on a monthly rolling basis at the DISC – plan to release a new version including interpolation to a fixed frequency grid – available for the entire mission
- New products include:
  - L1-A2C (AIRS to CHIRP, a CrIS-like Climate Hyperspectral InfraRed Product)
  - L1-G (gridded)
- New L1B Cal Subset as well as new Cal Subsets for L1C and L1-A2C